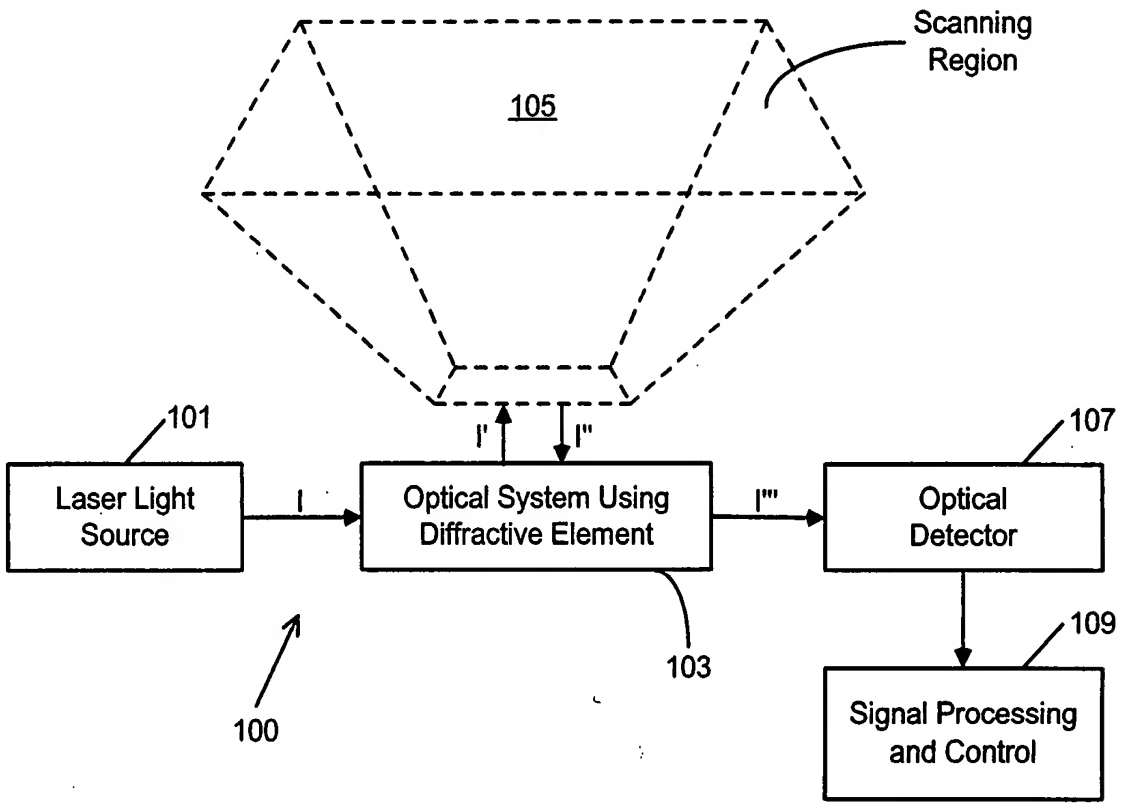

FIG. 1
PRIOR ART

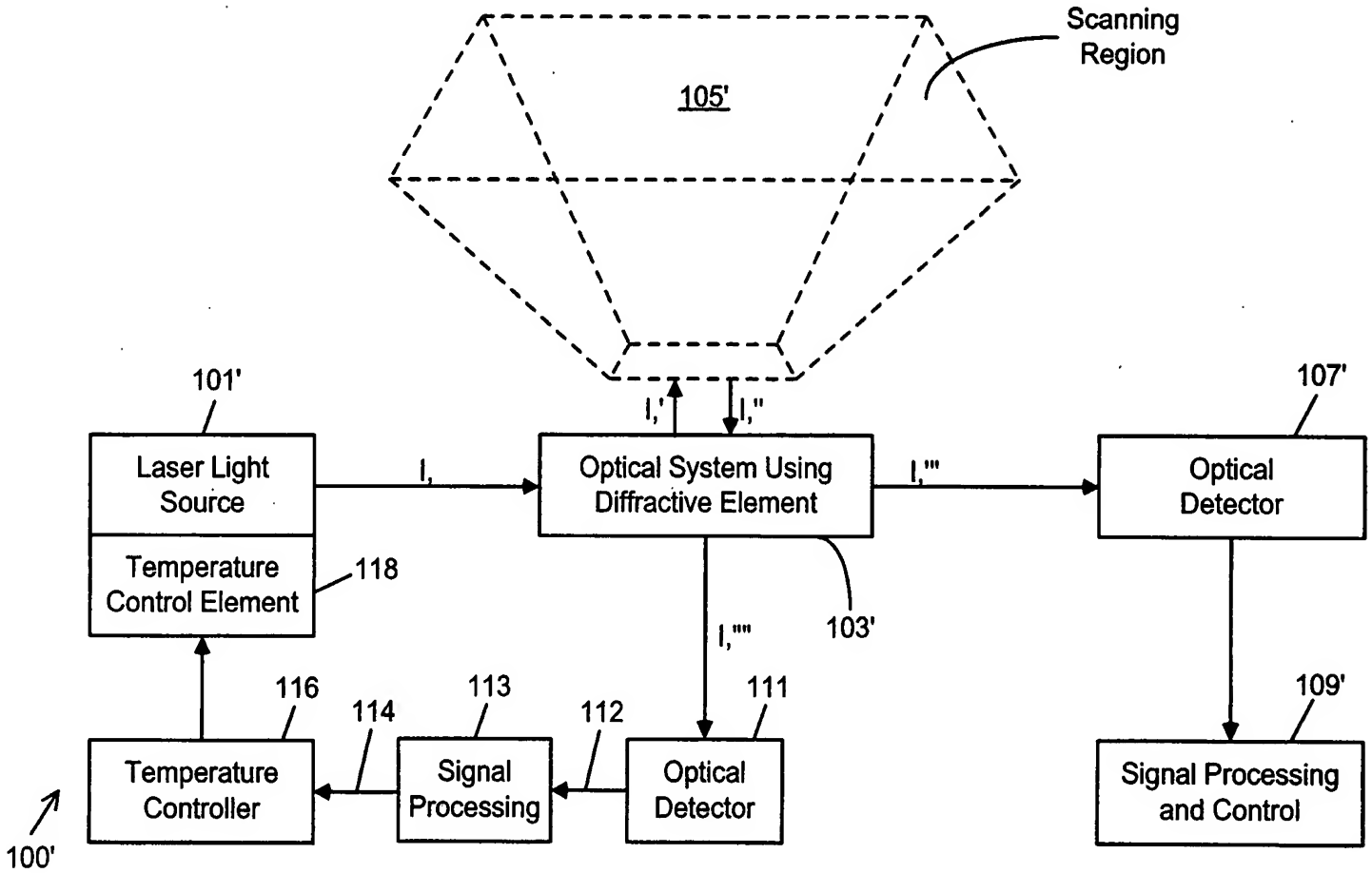
Scanning Region
105'
101'
107'
I,'
I,"
Laser Light Source
I,
Optical System Using Diffractive Element
I,'"
Optical Detector
Temperature Control Element
118
I,""
103'
116
114
113
112
111
109'
Temperature Controller
Signal Processing
Optical Detector
Signal Processing and Control
100'

FIG. 2

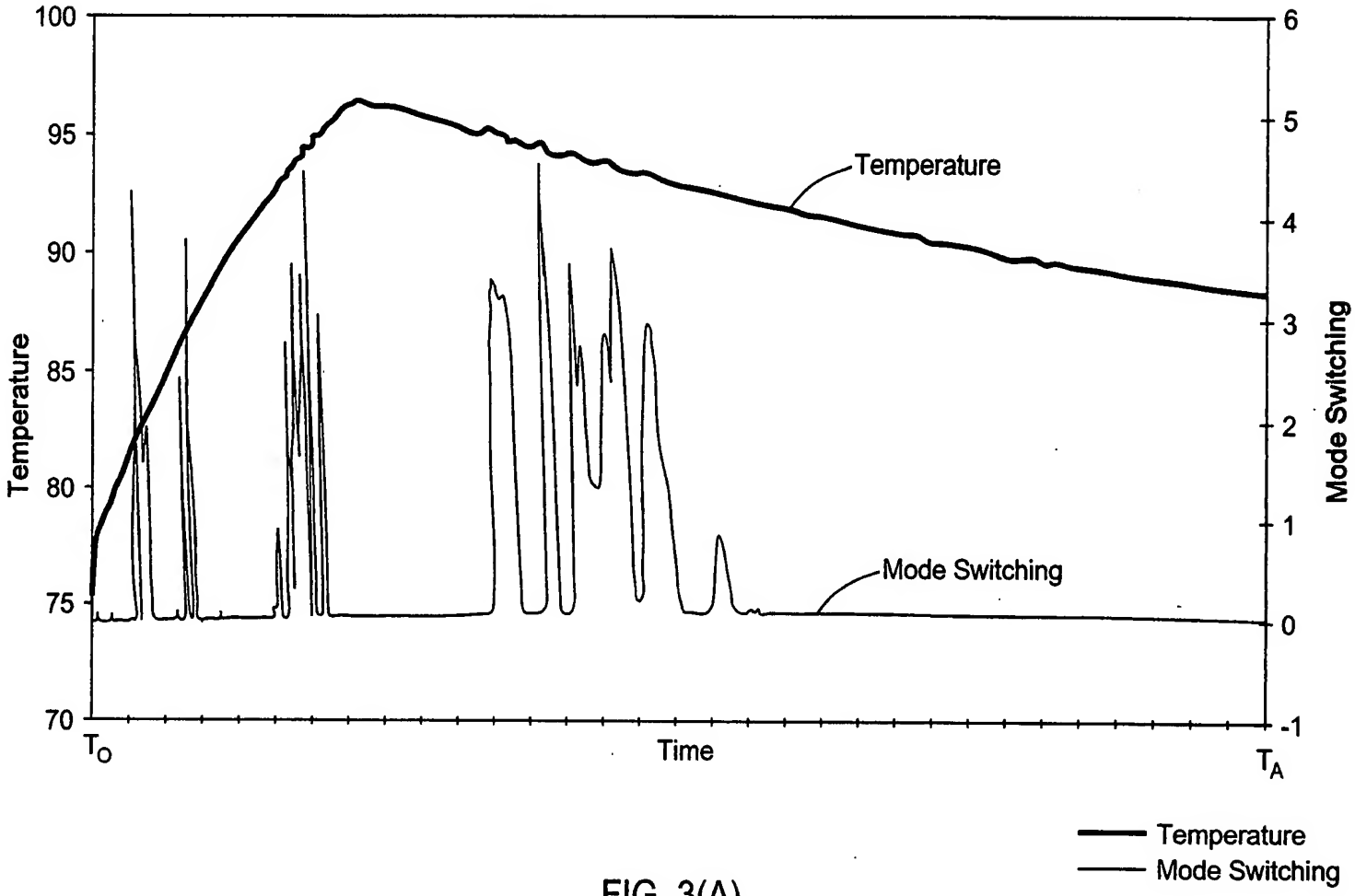
100
95
90
85
80
75
70
Temperature
6
5
4
3
2
1
0
-1
Mode Switching
Temperature
Mode Switching
T_O
Time
T_A
Temperature
Mode Switching

FIG. 3(A)

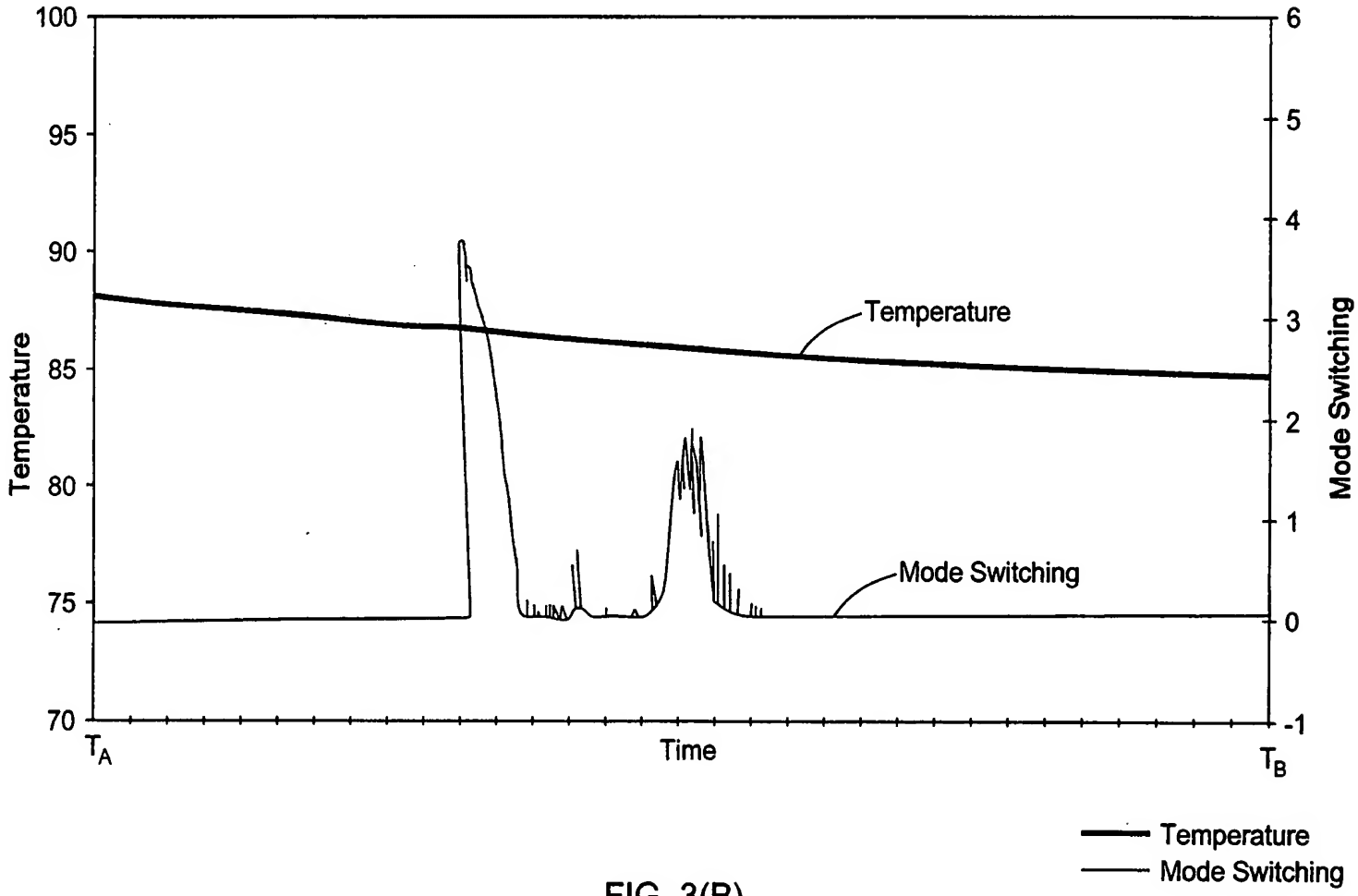
100
95
90
85
80
75
70
Temperature
6
5
4
3
2
1
0
-1
Mode Switching
Temperature
Mode Switching
T_A
Time
T_B
Temperature
Mode Switching

FIG. 3(B)

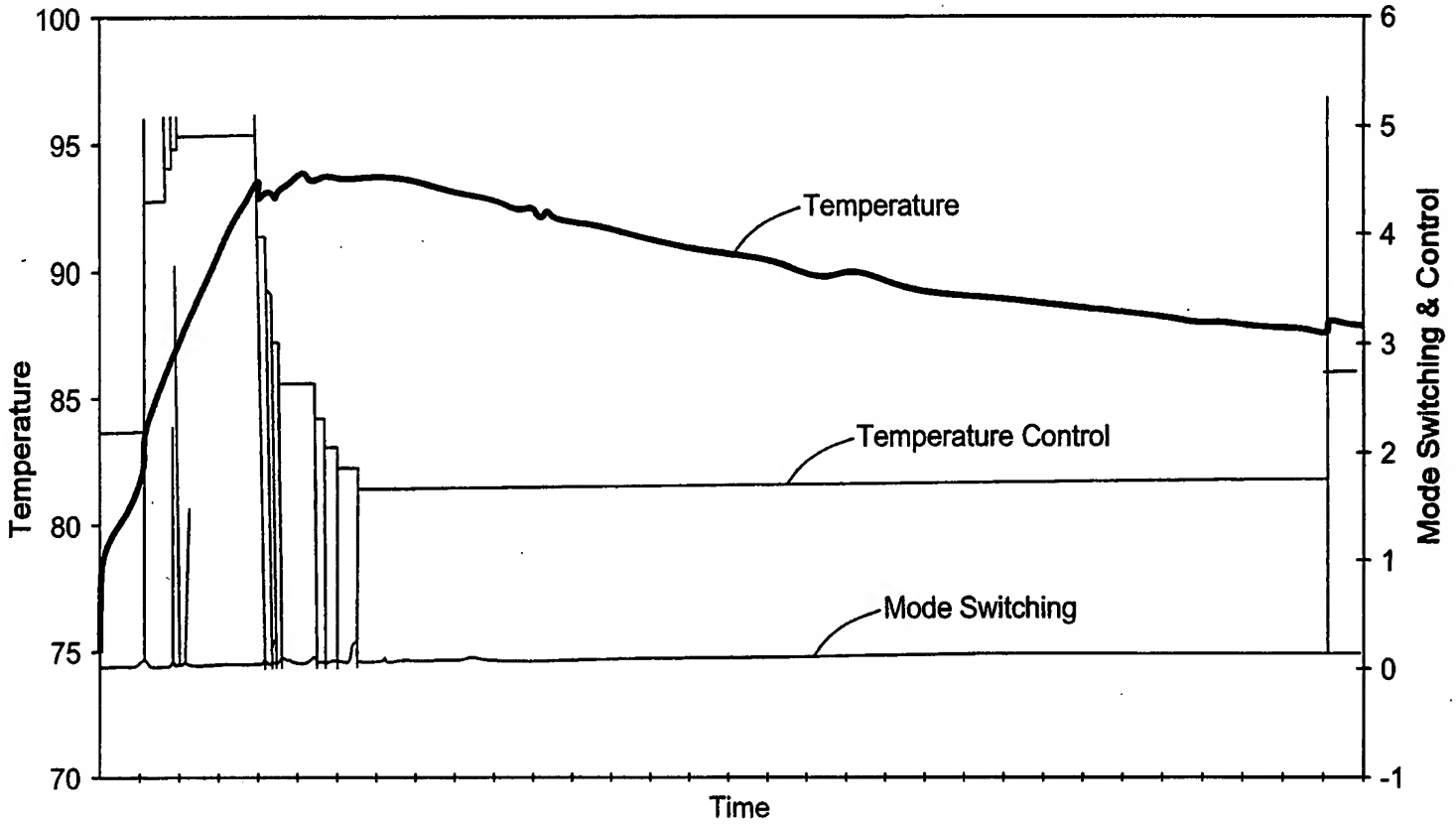
100
95
90
85
80
75
70
Temperature
6
5
4
3
2
1
0
-1
Mode Switching & Control
Temperature
Temperature Control
Mode Switching
Time

FIG. 4(A)

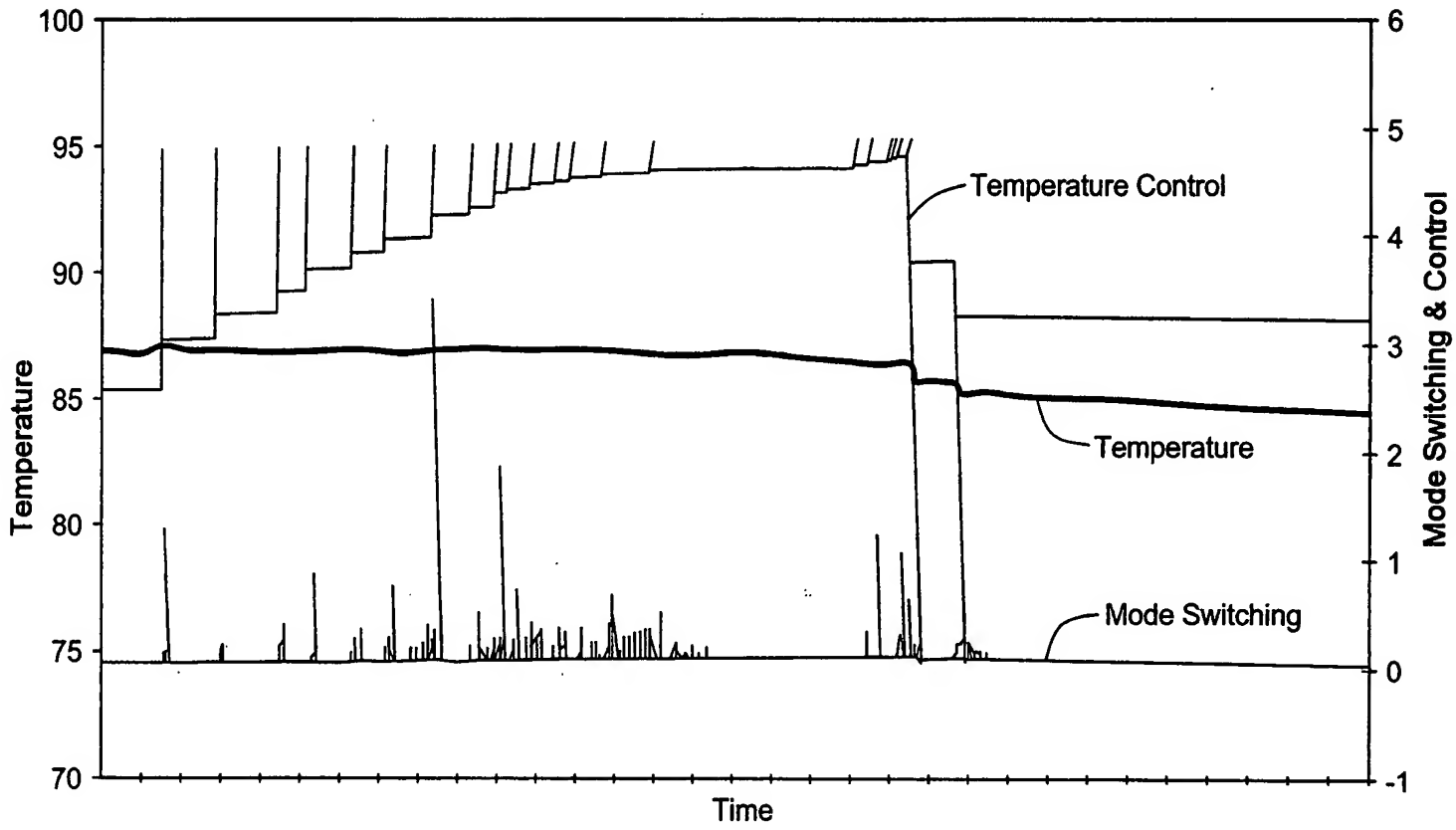
100
95
90
85
80
75
70
Temperature
6
5
4
3
2
1
0
-1
Mode Switching & Control
Temperature Control
Temperature
Mode Switching
Time

FIG. 4(B)

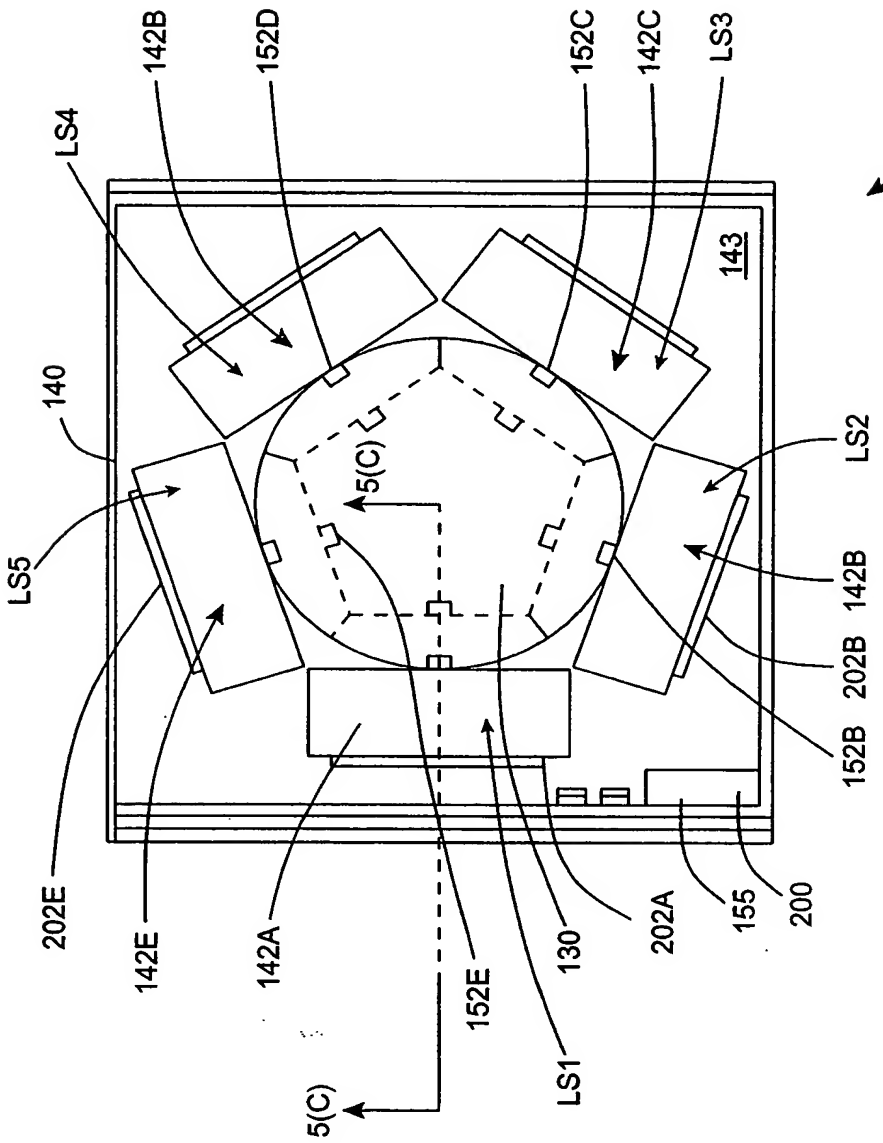
100-A
LS4
142B
152D
152C
142C
LS3
143
140
LS5
5(C)
LS2
142B
202B
152B
202E
142E
142A
152E
130
202A
155
200
5(C)
LS1

FIG. 5(A)

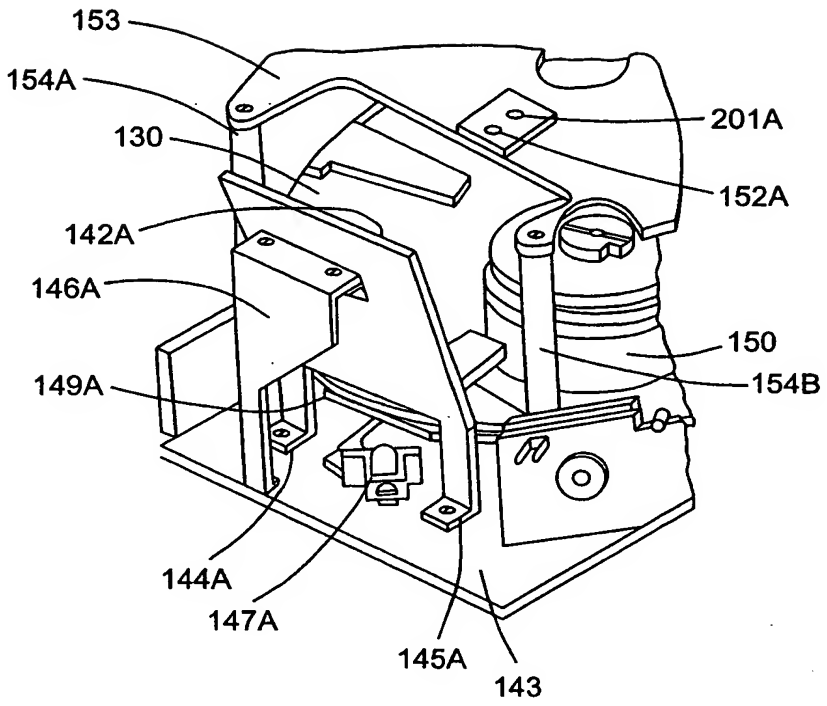
153
154A
130
142A
146A
149A
144A
147A
145A
143
201A
152A
150
154B

FIG. 5(B)

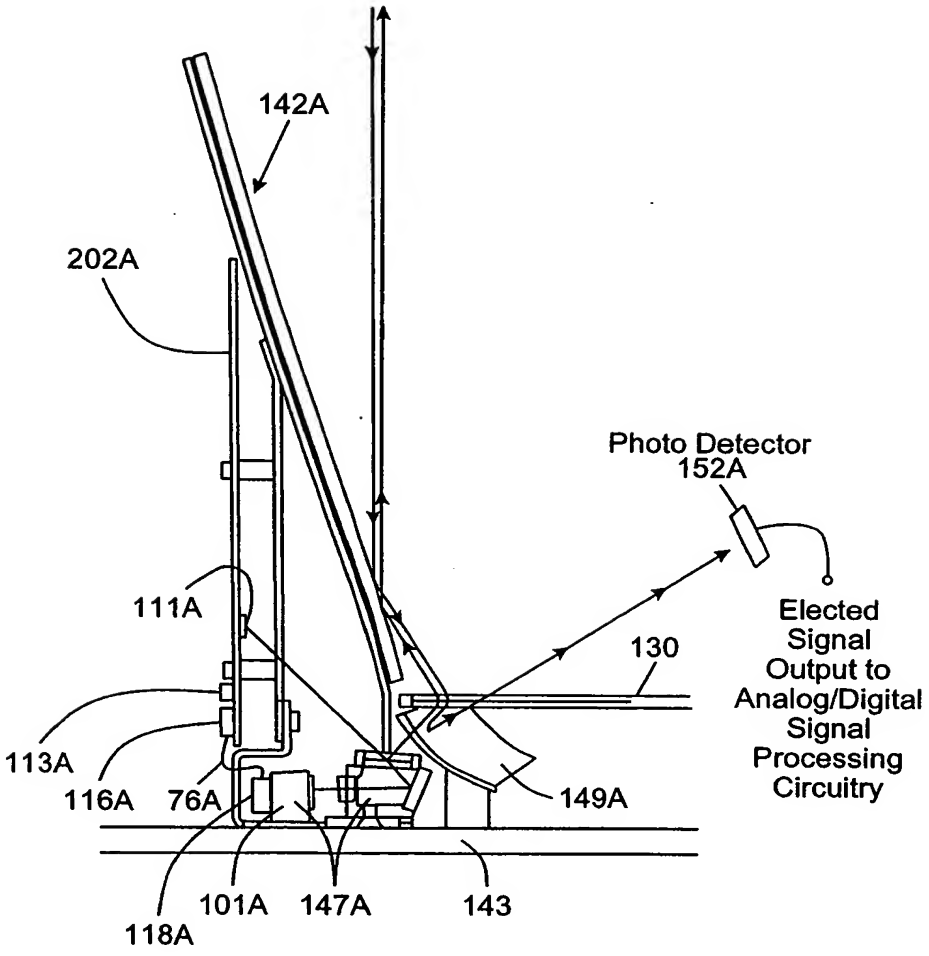
142A
202A
Photo Detector
152A
111A
130
Elected
Signal
Output to
Analog/Digital
Signal
Processing
Circuitry
113A
116A
76A
149A
118A
101A
147A
143

FIG. 5(C)

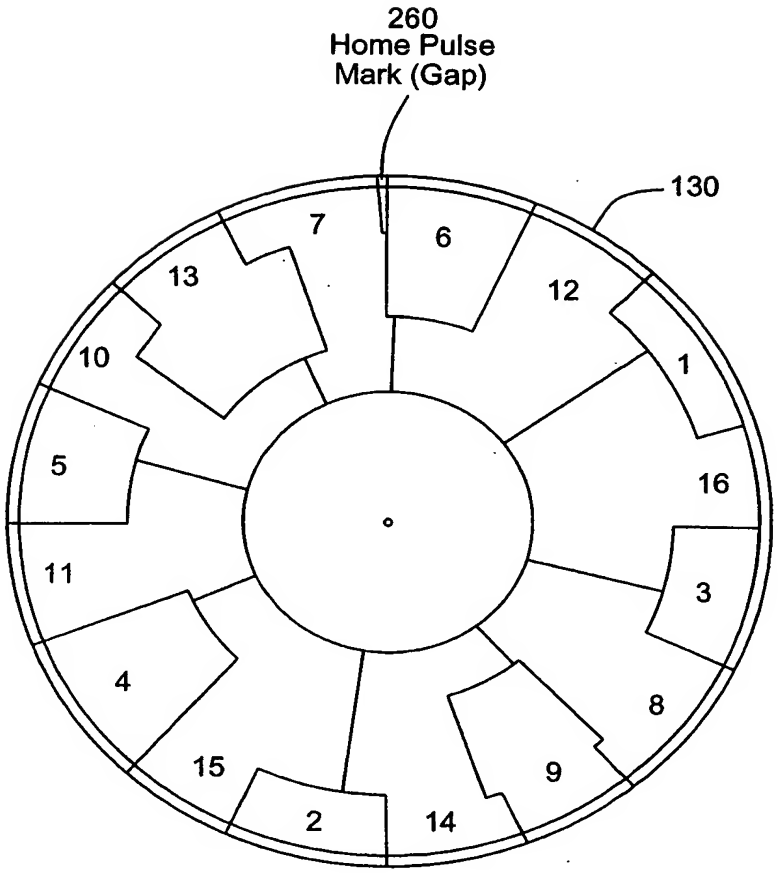

FIG. 5(D)

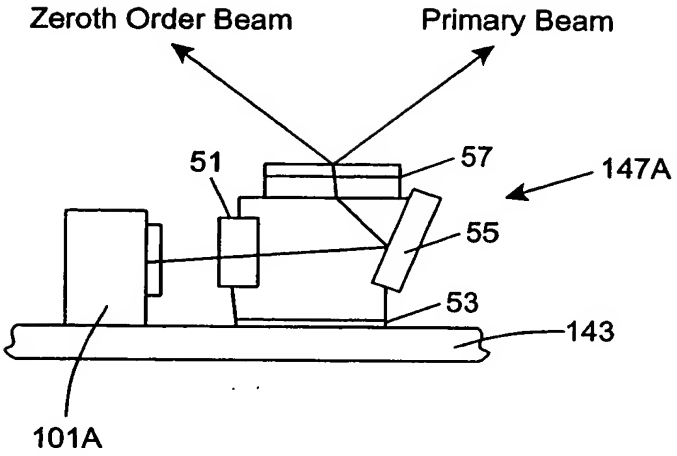

FIG. 5(E)(i)

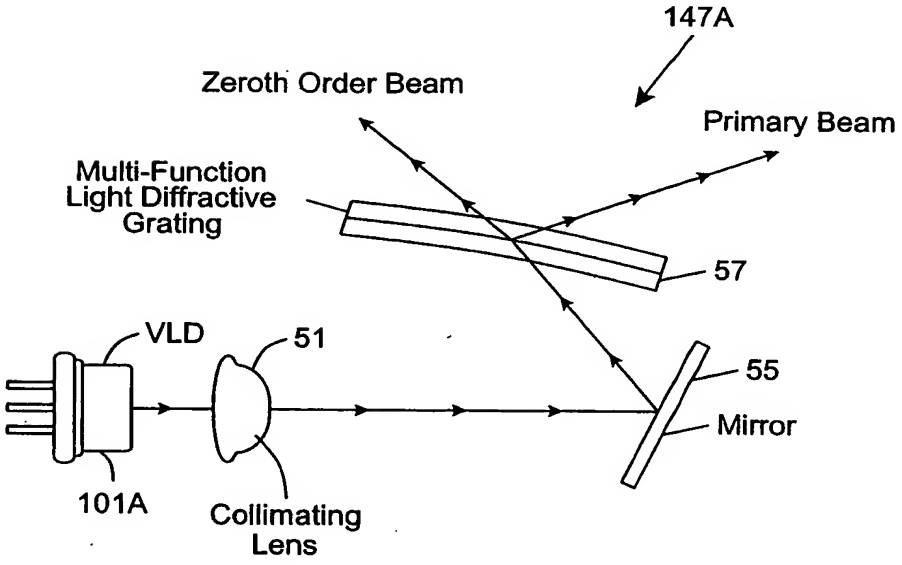

FIG. 5(E)(ii)

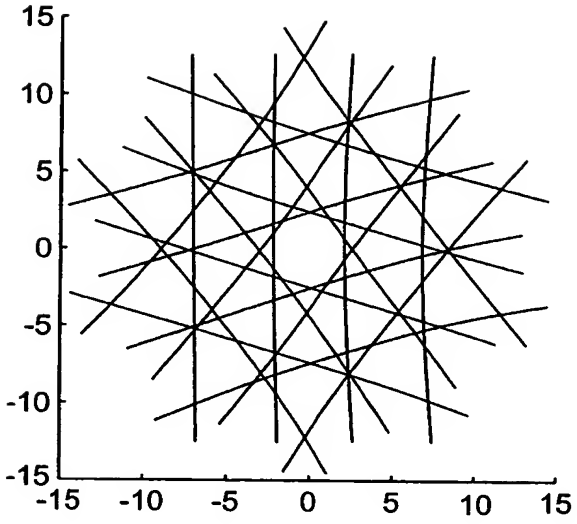

FIG. 5(F)

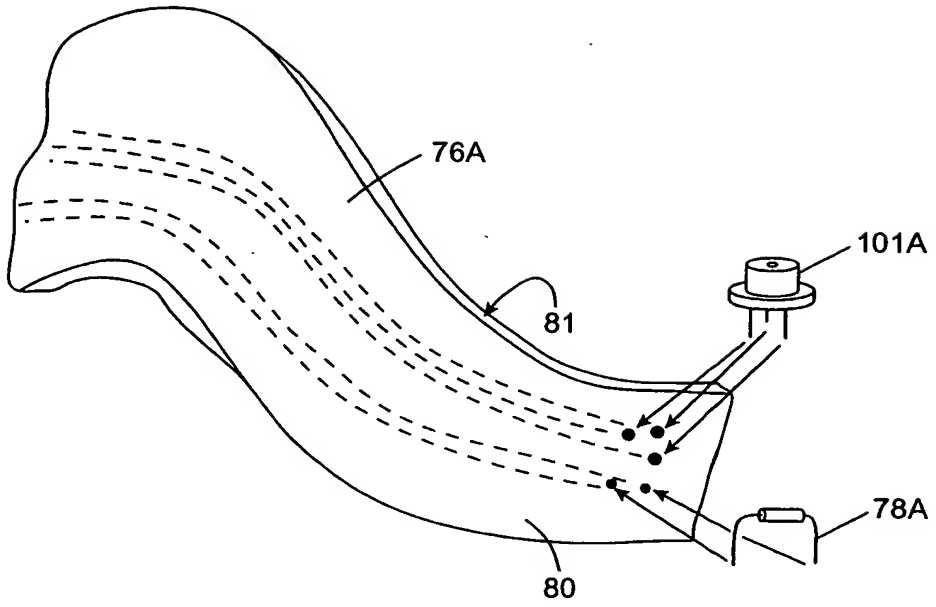

FIG. 5(G)

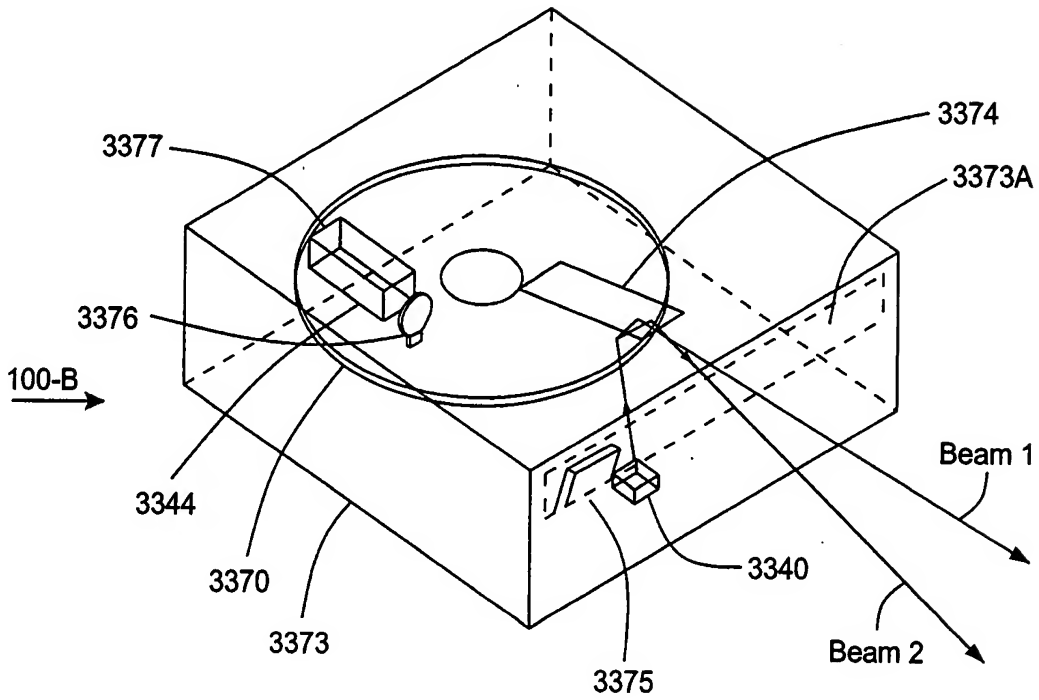
3377
3374
3373A
3376
100-B
3344
3370
3373
3375
3340
Beam 1
Beam 2

FIG. 6(A)

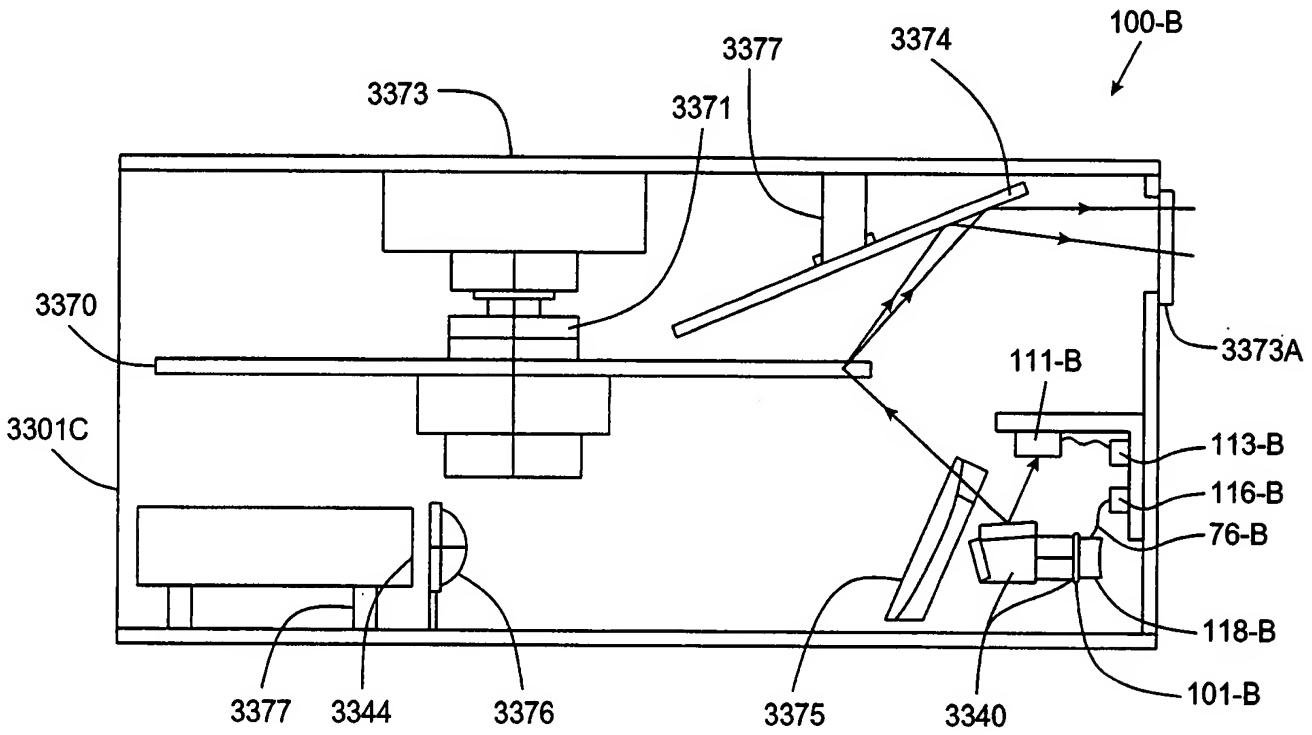
100-B
3377
3374
3373
3371
3370
3373A
111-B
3301C
113-B
116-B
76-B
118-B
101-B
3377
3344
3376
3375
3340

FIG. 6(B)

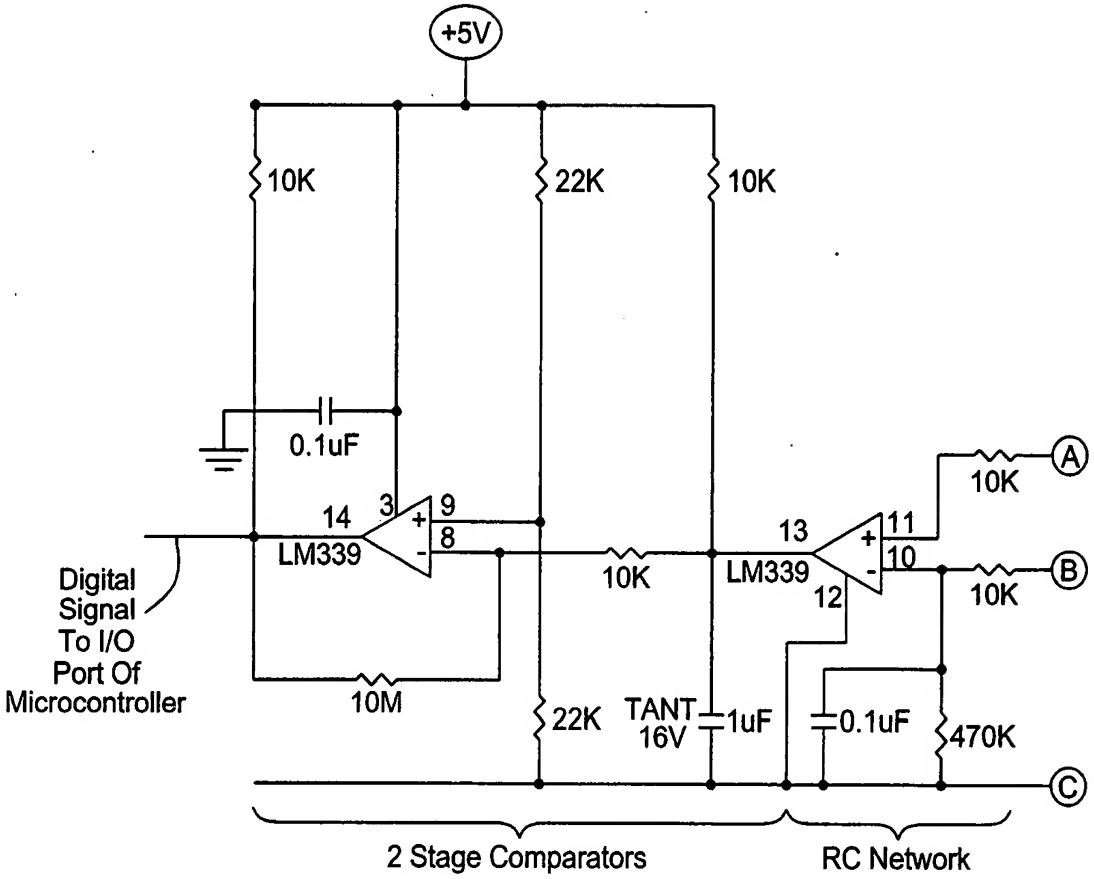
+5V
10K
22K
10K
0.1uF
14
3
9
8
LM339
Digital
Signal
To I/O
Port Of
Microcontroller
10M
10K
13
11
10
12
LM339
10K
A
B
10K
22K
TANT
16V
1uF
0.1uF
470K
C
2 Stage Comparators
RC Network

FIG. 7(A)(i)

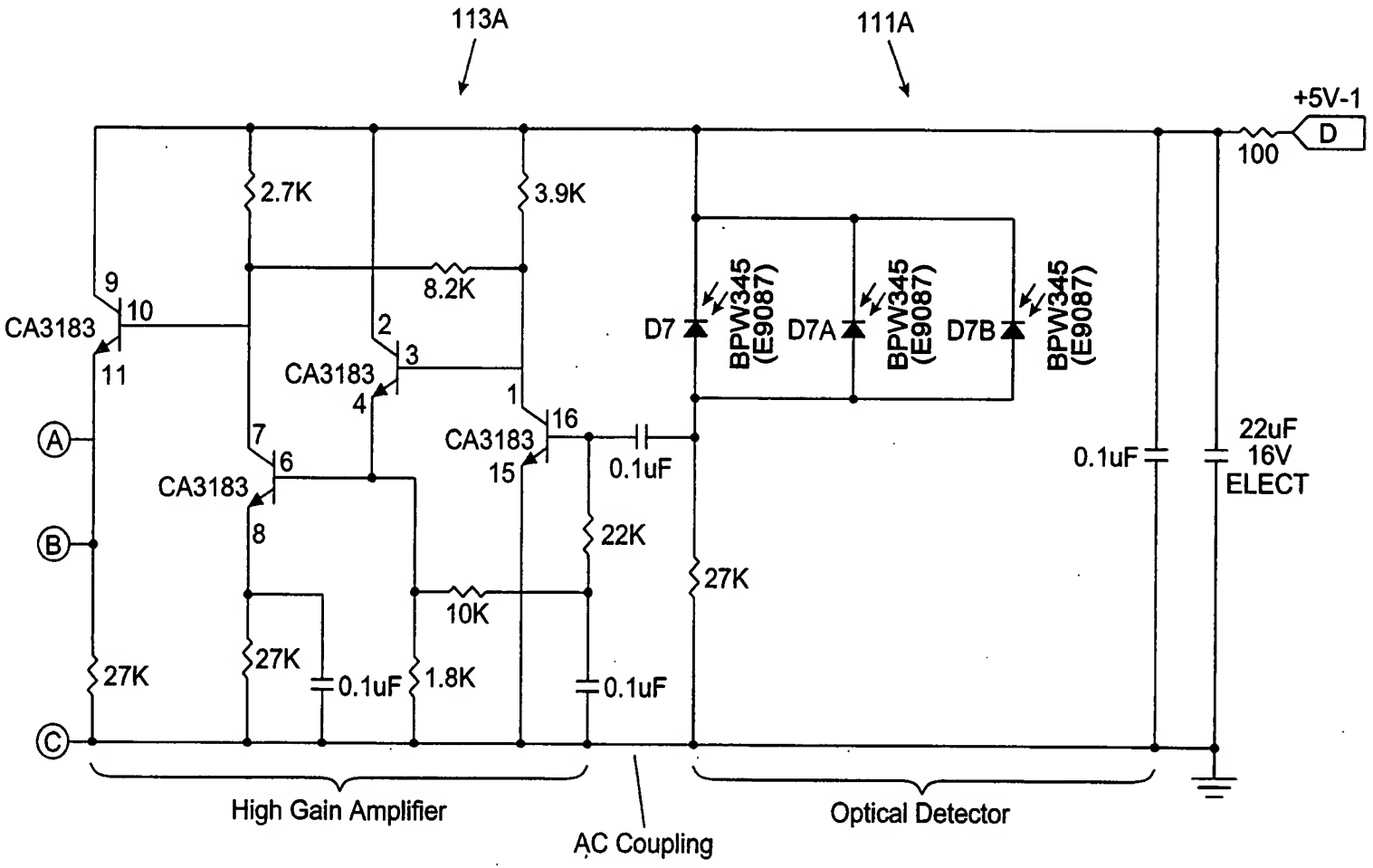
113A
111A
+5V-1
D
100
2.7K
3.9K
8.2K
9
10
CA3183
11
2
3
CA3183
4
1
16
CA3183
15
7
6
CA3183
8
D7
BPW345 (E9087)
D7A
BPW345 (E9087)
D7B
BPW345 (E9087)
A
B
C
0.1uF
22K
27K
10K
27K
0.1uF
1.8K
0.1uF
27K
0.1uF
22uF 16V ELECT
High Gain Amplifier
AC Coupling
Optical Detector

FIG. 7(A)(ii)

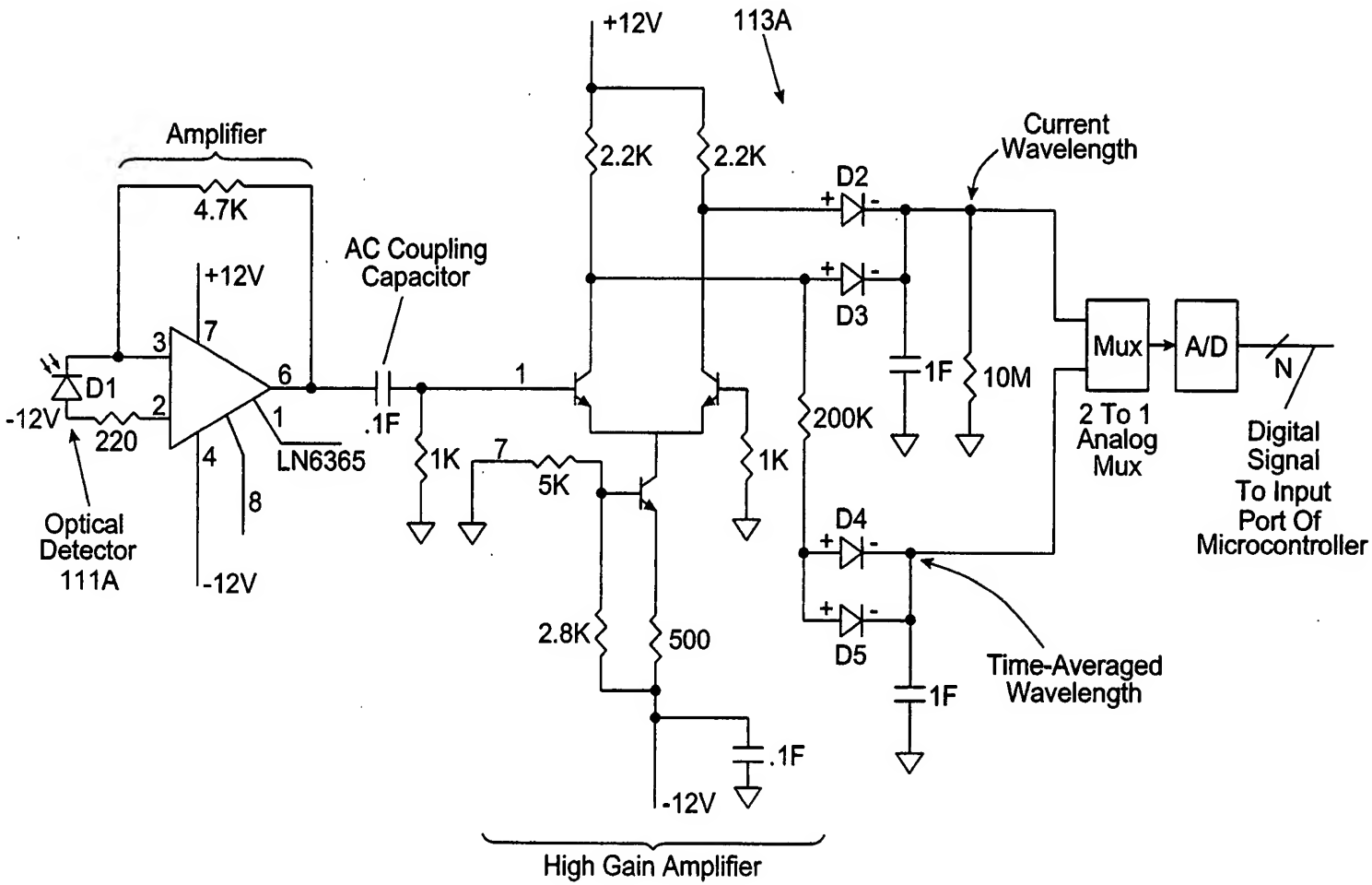
+12V
113A
Amplifier
4.7K
2.2K
2.2K
Current
Wavelength
D2
D3
AC Coupling
Capacitor
+12V
7
3
6
D1
2
1
-12V
220
4
8
LN6365
.1F
1
1K
7
5K
1K
200K
1F
10M
Mux
A/D
N
2 To 1
Analog
Mux
Digital
Signal
To Input
Port Of
Microcontroller
Optical
Detector
111A
-12V
D4
D5
2.8K
500
1F
Time-Averaged
Wavelength
.1F
-12V
High Gain Amplifier

FIG. 7(B)

```
10 init:
15      direction= UP;
20 main_loop:
25              if mode_switching = ON then:
30                      if Direction – UP then
40 heat_loop
50                              heat laser light source (set PW = 100%)
60                                      if mode_switching – OFF then
70                                              calculate new_PW to maintain temp
80                                              set PW to new_PW
90                                              jump to main_loop
100                                     else
110                                             if top_of_range_reached then
115                                                     Direction = DOWN;
120                                                     jump to heat_loop;
130                                             else
140                                                     jump to heat_loop;
150                                             end if;
160                                     end if;
170                     else /*****Direction = DOWN*****/
180                             cool laser light source (set W = 0%)
185                                     if mode_switching = OFF then
190                                             calculate new_PW to maintain temperature;
200                                             set PW to new_PW
210                                             jump to main_loop
220                                     else
230                                             if bottom_of_range_reached then
235                                                     Direction = UP;
240                                                     jump to heat_loop;
250                                             else
260                                                     jump to cool_loop;
270                                             end if;
275                                     endif;
280             else
290                     use PW to maintain temperature
300                     jump to main_loop
310             endif;
320 end
```

FIG. 8(A)

```
10 main_loop
20    if mode_switching = ON then begin:
30          if heat_power = lower (PW <=50%) then
40 heat_loop:
50                        heat laser light source (set PW = 100%)
60                              if mode_switching = OFF then
70                                    calculate new_PW to maintain temp
80                                    set PW to new_PW
90                                    jump to main _loop
100                             else
110                                   if top_of_range_reached then
120                                         jump to cool_loo;
130                                   else
140                                         jump to heat_loop;
150                                   end if;
160                             end if;
170         else /*****heat_power=high (PW>50%) ****/
175 cool_loop:
180                       cool laser light source (set PW = 0%)
185                             if mode_switching = OFF then
190                                   calculate new_PW to maintain temperature;
200                                   set PW to new_PW
210                                   jump to main_loop
220                             else
230                                   if bottom_of_range_reached then
240                                         jump to heat_loop;
250                                   else
260                                         jump to cool_loop;
270                                   end if;
275                             endif;
280         end if;
285   else
290         use PW to maintain temperature
300         jump to main_loop
310   endif;
320 end
```

FIG. 8(B)

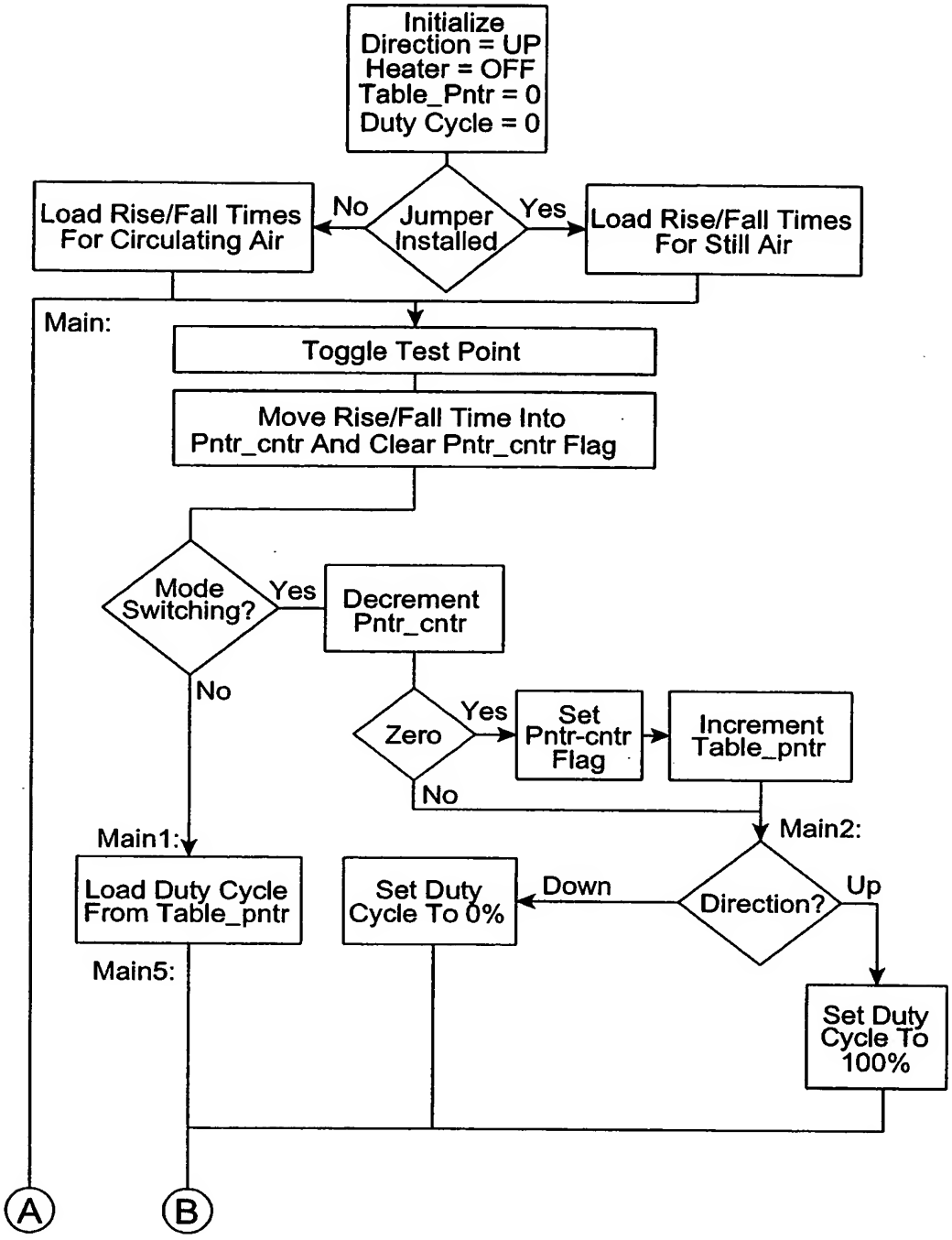
Initialize
Direction = UP
Heater = OFF
Table_Pntr = 0
Duty Cycle = 0
Load Rise/Fall Times For Circulating Air
No
Jumper Installed
Yes
Load Rise/Fall Times For Still Air
Main:
Toggle Test Point
Move Rise/Fall Time Into Pntr_cntr And Clear Pntr_cntr Flag
Mode Switching?
Yes
Decrement Pntr_cntr
No
Zero
Yes
Set Pntr-cntr Flag
Increment Table_pntr
No
Main1:
Main2:
Load Duty Cycle From Table_pntr
Set Duty Cycle To 0%
Down
Direction?
Up
Main5:
Set Duty Cycle To 100%
A
B

FIG. 8(C)(i)1

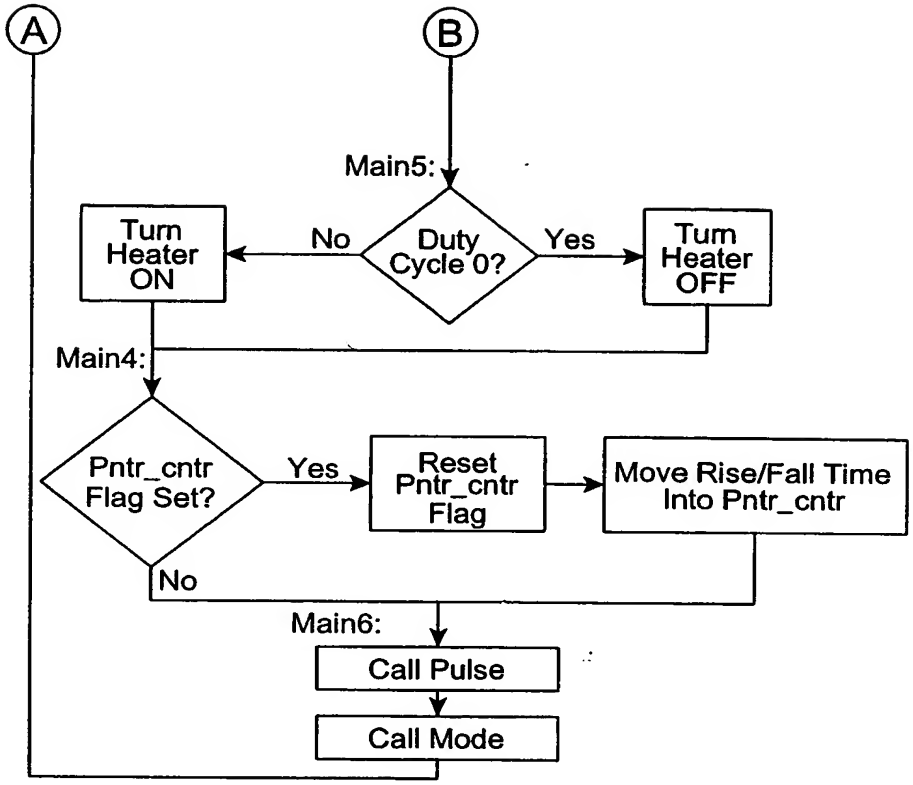
A
B
Main5:
Turn Heater ON
No
Duty Cycle 0?
Yes
Turn Heater OFF
Main4:
Pntr_cntr Flag Set?
Yes
Reset Pntr_cntr Flag
Move Rise/Fall Time Into Pntr_cntr
No
Main6:
Call Pulse
Call Mode

FIG. 8(C)(i)2

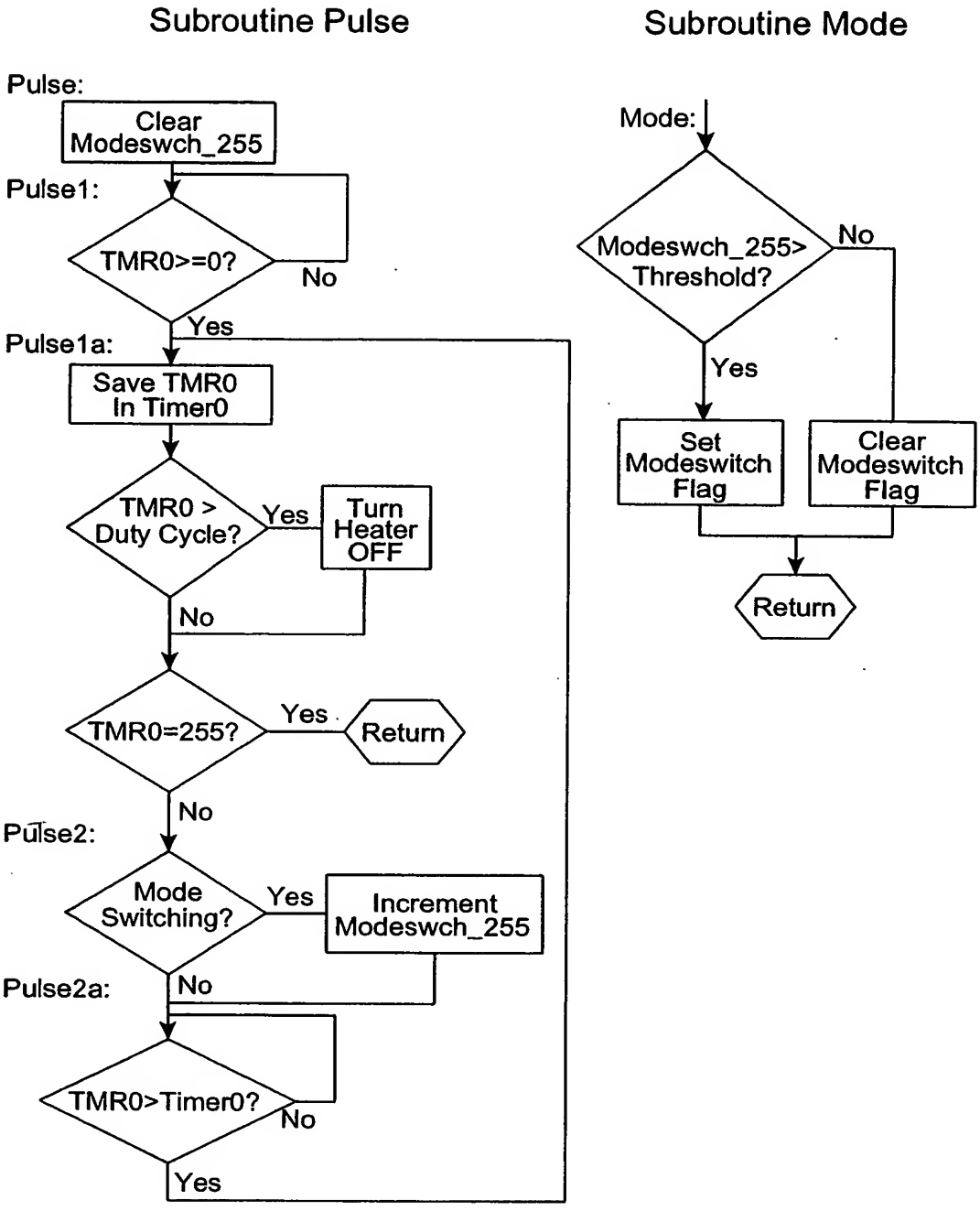
Subroutine Pulse
Subroutine Mode
Pulse:
Clear Modeswch_255
Pulse1:
TMR0>=0?
No
Yes
Pulse1a:
Save TMR0 In Timer0
TMR0 > Duty Cycle?
Yes
Turn Heater OFF
No
TMR0=255?
Yes
Return
No
Pulse2:
Mode Switching?
Yes
Increment Modeswch_255
Pulse2a:
No
TMR0>Timer0?
No
Yes
Mode:
Modeswch_255> Threshold?
No
Yes
Set Modeswitch Flag
Clear Modeswitch Flag
Return

FIG. 8(C)(ii)

```
; ************************************************************

        list            p=12c5-0            ; list directive to define processor
        #include        <o12c509.inc>       ; processor specific variable definitions

        __CONFIG    _CP_OFF & _WDT_OFF & _MCLR_OFF & _IntRC_OSC

; '__CONFIG' directive is used to embed configuration word within .asm filed.
; The labels following the directive are located in the respective .inc file.
; See respective data sheet for additional information on configuration word.

;***** VARIABLE DEFINITIONS
; Labels for variables
threshold           EQU  0x25  ; set threshold level for mode switching
modeswitch          EQU  0x30  ; Input signal location
heater              EQU  0x00  ; Output signal location
TP                  EQU  0x02  ; Test Point location
rise1               EQU  D'120'; first rise time (120*2 seconds) jumper IN
rise2               EQU  D'45' ; second rise time (45*2 seconds) jumper OUT
fall1               EQU  D'120'; first fall time (120*2 seconds) jumper IN
fall2               EQU  D'45' ; second fall time (45*2 seconds) jumper OUT

; Labels for memory locations
temp                EQU  0x07  ; example variable definition
duty_cycle          EQU  0x08  ; Pulse width modulation
modeswitch_255      EQU  0x09  ; counter to keep track of mode switching
timer0              EQU  0x0a  ; keep track of timer changes
rise                EQU  0x0b
fall                EQU  0x0c
table_pntr          EQU  0x0d
flags               EQU  0x0e
pntr_cntr           EQU  0x0f

;************************************************************
                    ORG  0x3FF          ; processor reset vector
; Internal RC calibration value is placed at location 0x1FF by Microchip
; as a movlw kk, where the kk is a literal value.

        ORG         0x000               ; coding begins here
        movwf       OSCCAL              ; update register with factory cal value

; remaining code goes here


; ***************INITIALIZE
```

FIG. 8(D)(i)

```
        MOVLW   0xc7            ; set up timers etc.
        OPTION

        MOVLW   0x3a            ; set up I/O
        TRIS    6

        CLRF    duty_cycle      ; set initial duty cycle to 0
        BCF     GPIO, heater; turn off heater
        BSF     GPIO, heater; turn off heater drive transistor

        MOVLW   rise1           ; Initialize rise and fall times to
        BTSFC   GPIO,5          ; setting setting, predetermined constants
        MOVLW   rise2
        MOVWF   rise
        MOVWF   pntr_cntr       ; initialize with rise time

        MOVLW   fall1
        BTFSC   GPI0,5
        MOVLW   fall2
        MOVWF   fall

        CLRF    flags
        CLRF    table_pntr

;******************MAIN LOOP

main:
        BSF     GPI0,TP         ; Toggle test point
        BCF     GPI0,TP

        BCF     flags,1         ; clear pntr_cntr flag

        BTFSS           flags,0         ; test mode switch flag
        GOTO    main1           ; jump if not set

        DECFSZ  pntr_cntr,1     ; if not 0, skip
        GOTO    main2
        BSF     flags,1         ; set pntr_cntr flag
        INCF    table_pntr      ; advance through table

main2:
        MOVLW   0xff            ; load 'up' direction
        MOVWF   duty_cycle      ; set for up direction
        BTFSC   table_pntr,5    ; if in 'up' direction, skip
        CLRF    duty_cycle
        GOTO    main5
```

FIG. 8(D)(ii)(a)

```
main1;
        MOVF    tabl_pntr,0     ; load table pointer in working register
        ANDLW   0x3f            ; strip off higher order bits
        CALL    table           ; fetch duty cycle from lookup table
        MOVWF   duty_cycle      ; load in duty cycle
main5:
        MOVF    duty_cycle,0 ; read in duty cycle
        BTFSS           STATUS,Z    ; if nonzero goto main3
        GOTO    main3
;       BCF     GPIO,0          ; if zero, turn OFF output
        BSF     GPIO,heater ; if zero, turn OFF, heater drive transistor
        GOTO    main4
main3:
;       BSF     GPIO,0          ; turn ON output
        BCF     GPIO, heater; turn ON heater drive transistor
main4:
        BTFSS           flags,1         ; if flag is set, reset pntr_cntr
        GOTO    main6
        MOVF    rise,0          ; reset pntr_cntr
        BTFSC   table_pntr,5  ; reset pntr_cntr
        MOVF    fall,0
        MOVWF   pntr_cntr
main6:
        CALL    pulse           ; pulse width modulation subroutine
        CALL    mode            ; update modeswitching, set mode bit
        GOTO    main            ; go back to main routine
```

FIG. 8(D)(ii)(b)

```
;**********SUBROUTINES

mode:                                   ; include mode switching
        BCF     flags,0                 ; clear mode switching flag
        MOVLW   threshold               ; put threshold value in accumulator
        SUBWF   modeswitch_255,0        ; compare
        BTFSC   STATUS,C                ; if modewsitch_255>threshold
        BSF     flags,0                 ; set flag0
        RETLW   0                       ; set flag

; Subroutine to generate pulse width modulation, monitor mode switching
; Prescaler set to 256  Therefore each pass is 256 usec, 256 passes produces
; 65 ms basic period for mode switching.

pulse:
        CLRF    modeswitch_255          ; Initialize mode switching register
pulse1:
        INCF    TMR0,0                  ; wait until TMR0 increments past 0xFF
        BTFSC   STATUS,Z
        GOTO    pulse1
pulse1a:
        MOVF    TMR0,0                  ; load timer into W
        MOVWF   timer0                  ; put in timer0 monitor

        MOVF    timer0,0                ; move timer0 monitor into W
        SUBWF   duty_cycle,0            ; compare duty cycle with timer0
        BTFSS           STATUS,C                ; if borrow occurs, then
        BCF     GPIO, heater            ; clear output
        BSF     GPIO, heater            ; turn OFF heater transistor

        INCFSZ  timer0,0                ; if timer – 255, exit from loop
        GOTO    pulse2
        RETLW   0
```

FIG. 8(D)(iii)(a)

```
pulse2:
        BTFSC       GPI0,modeswitch   ;If GP3 is high, then
        INCF        modeswitch_255,1  ; increment modeswitch
pulse2A:
        MOVF        timer0,0
        X0RWF       TMR0,0
        BTFSC       STATUS,Z
        GOTO        pulse2a
        GOTO        pulse1a

;**********TABLES
        radix       dec
table:
        addwf PCL
        dt 0,24,46,66,84,100,115,128,140,151,161,170,178,186,192,198
        dt 203,2008,214,217,200,224,237,339,332,234,236,238,23,241,242,255
        dt 255,231,209,189,171,155,140,127,115,103,94,86,77,69,63,57,51,47
        dt 42, 38, 35, 31, 28, 26, 23, 21, 19, 17, 16, 16, 14, 13, 0
```

FIG. 8(D)(iii)(b)